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CARNIVOROUS PLANT NEWSLETTER

VOLUME 14, Number 1 MARCH 1985

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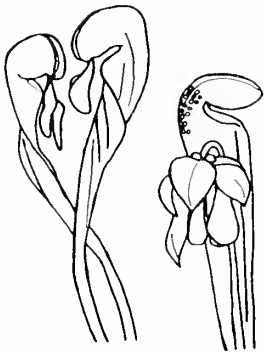

CARNIVOROUS PLANT NEWSLETTER

Official Journal of the
International Carnivorous
Plant Society

Volume 14, Number 1
March 1985

COVER PHOTO

Brocchinia reducta, a bromeliad newly described as carnivorous. Photo by T.J. Givnish, Harvard University. See article, page 24.

The co-editors of CPN would like everyone to pay particular attention to the following policies regarding your dues to the ICPS.

All correspondence regarding dues, address changes and missing issues should be sent to Mrs. Pat Hansen, 3321 Hamell Rd., Fullerton, CA 92635. DO NOT SEND TO THE CO-EDITORS. Checks for subscriptions and reprints should be made payable to CSUF FOUNDATION-ICPS.

All material for publication, comments and general correspondence about your plants, field trips or special noteworthy events relating to CP should be directed to one of the co-editors. We are interested in all news related to carnivorous plants and rely on the membership to supply us with this information so that we can share it with others.

Views expressed in this publication are those of the authors, not necessarily the editorial staff.

Copy deadline for the September issue is July 1, 1985.

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News and Views

THOMAS ALT (Waldstrasse 12, 6610 Lebach-Aschbach, West Germany)

I have enclosed for you the first German language CP newsletter from our society which is called "DAS TAUBLATT". It will appear 4 times each year. The society has at the moment approximately 65 members and we hope to have more. The membership cost is 20 DM a year or about $7.00 US dollars. Each newsletter will have two or three color photos of different CP species pasted into the centerfold. We welcome new members.

ORGEL C. BRAMBLETT (18950 S.W. 136th St., Miami, Florida 33187)

I hope all is well and old man Winter has not been too hard on you. It's nice here now but the one cold spell really killed us since it got down to 21°F (–6°C) and that's really bad news for people like me who have their plants growing under shade cloth.

We place a C.P. display in the Fairchild Gardens again this year at their annual Ramble. The ramble took place Dec. 1 & 2, 1984 with perfect weather and the event was well attended. Ron Pratt, Craig Johnson and myself put the display together using species of Sarracenia (8 species and various hybrids), and the usual V.F.T. (bulbs and plants) and 12 different species of Drosera. In addition, there was Cephalotus, Utricularia, ten species of Pinguicula and of course Nepenthes. We had about 25 different species and hybrids of Nepenthes with a lot of interest shown for these plants and we gave out quite a few CPN applications.

OLIVER BRODT (Amselweg 5, 7024 Filderstadt 4, West Germany)

In the recent CPN 13, No. 3, I read the article "Sundew as Officinal Plant." I am a

Craig Johnson (right) explains CP to visitors at Fairchild Gardens (Miami) annual Ramble.

bit indignant about this article.

You publish a journal for plant cultivators and then you show an advertisement for cough drops made from sundews. That's stupid! You publish the address of the firm, but you don't know whether the firm is injuring the existence of *Drosera rotundifolia* in Finland or not. Every plant that is threatened today was a plant that grew in almost every suitable area in the past. You must stop publishing this type of material immediately and not when it is too late and when the plants are nearly gone. You are encouraging people to buy these cough drops. News of their existence are spread all over the world. The result will be that more cough drops are sold and the firm will collect more and more plants leading to a situation in which the plants are threatened. I hope that you won't print such irresponsible and inconsiderate articles in the future.

HENRY J. DEMMINK (2965 East Leonard, Grand Rapids, MI 49505)

I noted that Gunter Zipert is looking for a couple of out-of-print CP books. He can try:

D & E Lloyd
"Heather Lea"
4 Hillcrest Ave.
Chertsey, Surrey
ENGLAND KT169 RD

He has several copies of Schwartz' book at 6.50 pounds (about $7.50 U.S.) which are used books in very good condition. You might be interested in his catalogue list which contains 2009 different items in all phases of horticulture.

RUEDI FURST (Platte, CH-8547 Gachnang, Switzerland)

I read my article "Sundew as Officinal Plant" in issue #3 of CPN and found that I forgot to give you my address. I'm sorry about that mistake. My address is written as shown above.

DAVID LANE (62 Oak St., Dover, NH 03820) would like to see more photographs of large collections (both private and commercial) in CPN. Descriptions of the scope, arrangement and cultural conditions of plants grown in greenhouses, under artificial light or in terraria would be very helpful.

JOE MAZRIMAS reports that on a recent PBS network program originally shown on Jan. 20, 1985 in the "Nature" series was a show titled "Kinabalu: Summit of Borneo." On this program, many plants were shown that grow only in the forests of this mountain. Orchids, rhododendrons, giant fungi and *Nepenthes villosa* and *rajah* were shown as they grow in their native environment.

PIERRE SIBILLE (41 Rue Henri II Plantagenet, 76100 Rouen, FRANCE)

I enclose the October issue of our French language CP newsletter from the French amateurs association named "DIONEE." We publish 3 issues/year at the subscription price of 60 francs. I am the secretary and our president, Pierre Tourmente, is an adherent of ICPS. In a general way, we wish to have open and friendly relations with your association. Eventually, we would like to affiliate "DIONEE" with ICPS.

CLAUS THIEDE (Goslarsche Str. 70, D-3300 Braunschweig, West Germany)

I wrote to Joe Mazrimas asking him if there was any information he can provide aout a chemical known here as deoxygibberellic acid and its effect on germination of seeds. On the label of the solution of this chemical was an address which I gave to him. Joe wrote to the company and this is what they said:

7-deoxygibberellic acid is also known as gibberellin GA7 which is a mixture of GA4 and GA7 and according to the ICI has remarkable seed germination properties. This index also goes on to say that it's to be applied to seeds at a concentration of 200 to 2,000 parts per million. According to the enclosed patent specification, this precise chemical is made by the fungus *Gibberella fujikuroi* in culture and due to drastic change in culture conditions, namely a pH change of the medium, this particular derivative is made.

I am able to supply your readers with this product for the following prices, plus air mail postage and packaging to the U.S. Payment is preferred by way of an International Money Order if at all possible.

30ml GA7 5.40 pounds plus 2.00 pounds for postage.

60ml GA7 9.90 pounds plus 3.00 pounds for postage.

90ml GA7 14.00 pounds plus 4.00 pounds for postage.

For all practical purposes, add about 10% to above figures for conversion to U.S. currency. The address is:

Sunningale Sales
8, Squarefield Gardens
Hook, Basingstoke,
Hants RG27 9OH
ENGLAND Tel. 025672.3830

SEED BANK

Patrick Dwyer (St. Michael's Episcopal Church, 49 Killean Park, Albany, NY 12205)

To send seed: Please remove seed from the seed capsules and place it in small envelopes (preferably paper so that they dry out enough to prevent mold). Label with the origin and date of collection, including habitat if it is exotic. Fold the envelope once or twice before taping so that the seeds don't stick to the tape. After the seed is received it will be placed in smaller packets; donors will be informed of how many packets they have donated. A donation of 10-19 packets earns one free seed packet of comparable rarity, with one additional free packet for each additional 10 packets.

Do not ask to trade for seed from the bank. Everyone will have to buy all but the free packets.

To order seed: Please enclose payment. List the seeds desired and an equal number of substitutes in order of preference. If requested, Patrick will add any cultural instructions of which he is aware. Each issue of CPN will include an update of the inventory. Cost per packet: $.75. (Number of packets is listed if less than 15 are available.)

Byblis liniflora; Darlingtonia californica; Dionaea muscipula; Drosera auriculata, D. binata, D. binata multifida (2), *D. burmannii, D. capensis, D. capensis* "Merry Go Round" (cristate?), *D. capensis* (narrow) *D. capensis* (mix), *D. capillaris, D. communis* (4), *D. dielsiana, D. filiformis filiformis* (10), *D. glanduligera* (4), *D. indica, D. indica* (Australia) (10), *D. intermedia, D. macrantha, D. montana* (10), *D. natalensis* (1), *D. pallida* (3), *D. peltata, D. pygmaea* (2), *D. ramellosa* (2), *D. rotundifolia, D. rotundifolia* (forked stalks), *D. spathulata, D. spath.* (Formosa) (2), *D. spath.* (Kansai), *D. spath.* (Kanto), *D. spath.* (white), *D. stenopetala* (5), *D. stolonifera, D. trinervia* (7); *Nepenthes albomarginata, N. khasiana; Pinguicula primuliflora* (1), *P. vulgaris* (3); *Polypompholyx multifida, P. tenella* (10); *Sarracenia alata* (2), *S. flava* (red tube & green lid), *S. flava rugelii* (10), *S. minor* (5), *S. purpurea venosa* v. *chipoca* (10), *S. rubra gulfensis* (3), *S. rubra wherryi, S.* × *formosa* (1), *S.* × *readii* (2), *S. leucophylla* (red form) (3), *S. leucophylla* (tall thin red form), *S. leucophylla* (large stocks), *S. oreophila, S. purpurea purpurea, S. purpurea venosa, S. rubra* (3), *Sarracenia* hybrid mix, *S. (oreo* × *purp)* × *purp. purp.* (3), *S. flava* × *purp.* × *chelsoni* (10), *S. rubra* × *oreo* (10), *S. rubra gulf/leuco* (3), *S. leuco/minor* (3), *S. alata/minor* × *psitt/oreo, S. flava/leuco, S. alata/minor, S. purp/leuco; Utricularia dichotoma* (2), *U. gibba* (1), *U. hookeri* (3), *U. lateriflora* (4), *U. peliculata* (4), *U. subulata* (1), *U. uliginosa* (2), *U. violaceae* (4).

Reminiscences

by Donald Schnell

With this issue of CPN, we are beginning a new regular feature on a trial basis. We will be looking back over the past thirteen years of CPN and present again certain portions of articles, comments, News and Views and so forth, mainly from an anecdotal and often an ironic point of view. Sometimes we will point out inconsistencies, sometimes proposed projects we never heard from again, and sometimes some apparent key features that seem somewhat of a landmark and which may have gone ignored or which we now take for granted. The feature will also allow those relatively recent subscribers who do not have access to back issues for various reasons to see what has been going on. Subscribers who have been with us longer—perhaps for the whole nine yards—may enjoy re-reading about some things that might have slipped busy minds. I have often looked through my back issues and have been fascinated with the volume of important material that has been printed over the years.

Let us know how you like—or do not like—this new column. And by all means, if an article of yours or an old comment or suggestion is mentioned, write us and let us know what has been going on with your ideas and experience since then. We would all like to know. In some cases we have been left hanging for years after a final line reading ". . . and I will let you know how this turns out." All too often, we never did find out. If you are still with us, let us know.

For reference purposes, any quotes or summations of old material will be followed in parentheses by an abbreviated CPN bibliographic quote, such as (CPN6:119), which means you can find it in Volume 6 of CPN on page 119. I hope the quotes do not become too distracting, but they really are necessary for folks who might want to check for more details.

So, here we go . . .

* * * * *

Going WAY back to the beginning, I wonder if Robert Griesbach had any luck in inducing polyploidy in Droseras as he was attempting to do (CPN 1:2). Far from being an academic endeavor only, such research would have important implications in light of the most popularly accepted theory of the origin of fertile *Drosera anglica* as a polyploid of the hybrid *D. linearis* × *D. rotundifolia*.

Back when we were small and the subscriber list smaller, we used to list the new subscribers with each issue along with any information they would send along about what they were doing with CP, or planned to do. Back in the very first issue (CPN 1:3) is listed Katsuhiko Kondo who at that time was a graduate student at the University of North Carolina at Chapel Hill. It was mentioned that he was intereseted in chromosome studies of CP. Time has been kind and true to Katsu: he is now on the Botany staff of the University of Hiroshima, and over the years has published prolifically on his chromosome studies of various CP along with trying to tie it all together on the various possible relationships of CP groups. No year has gone by without several of Katsu's papers reviewed in the CPN Literature Review section.

Several times each year, water problems are mentioned in CPN by various people. There has been much discussion of hard vs. soft water, the value of rain water, and even suggestions that a touch of sodium chloride in water is helpful to the growth of *Cephalotus follicularis*, or does the species just tolerate it? I think we might back up a couple of years and review Warren Stoutamire's early article on how to rather simply monitor total salts content of water (CPN 1:6), using both water from the tap or barrel or bottle or whatever, *and* measuring the total salts content of water draining from our pots to see what is in the soil and is dissolved by watering, or perhaps what is absorbed by various soils or peat. Warren suggested a simple bridge electronic device to measure conductance of the aqueous

solution in uMho, thus giving an estimate of total ionized material present. He gave some figures varying from 2 uMho for double distilled water, to 20-40 for various mixtures in which CP were successfully growing, to Akron City water which weighed in at 250 uMho! There are simple formulas for converting ppm of hardness to uMho and the reverse, and over the years less expensive commercial instruments have become available and are quite handy. I have one here as a matter of fact and use it rather regularly. Of course, as Warren emphasized, the whole business is a kind of estimate since the *kinds* of ionized material present are important as are little things like temperature at time of measurement.

From the "ouch!" department, I notice the first of our valiant attempts to induce the acceptance of the genus name *Chrysamphora* for the California pitcher plant (CPN 1:8) in place of *Darlingtonia*. Well, we were all learning in those days and it took many issues to finally decide and accept that *Darlingtonia* was indeed proper thanks to the political machinations of the ICBN in conserving the name. But in the meantime, *Chrysamphora* surely enjoyed more print than any other time since it was initially proposed! At risk of seeming quixotic, *Chrysamphora* did have a uniquely descriptively ring to it and seemed so appropriate. Oh well.

Our now old friend Steve Clemesha first came to light in our very first volume (CPN 1 :17) and we have often heard from him since and will be quoting his articles in future columns. Steve has lived in two rather different areas of Australia over the years and has had phenomenal good luck and skill in growing many US CP from seed or minimum segments of small rhizomes into mature plants in record time, particularly Sarracenias which thrive in his hands. Some of his plants are into many generations now, including artificial hybrids. His photos sent us over the years show many beautiful plants.

In the initial flyer announcing the beginning of CPN, Joe Mazrimas and I stated as one of our purposes to increase communication among all CP enthusiasts, some who might live right around the corner from each other and not know it. Well, the communications aspect took a giant leap when midway through volume one we began receiving large numbers of Japanese subscribers, most of whom were members of the Insectivorous Plant Society of Japan (IPSJ). These gentlemen had been growing and working with CP for many, many years, and as a result of all this, many new friendships and important plant and information exchanges began that have flourished to this day.

As a matter of fact, Isamu Kusakabe mentioned a curiosity, a peculiar attraction of the local neighborhood cats to his plants of *Drosophyllum* rather specifically. They broke into the greenhouse on several occasions and made straight for the Drosophyllums, trampling over other potential delectables along the way. Mr. Kusakabe wondered then if anyone had noticed this also—Perhaps not an earthshaking thing in and of itself, but still curious. My wife and I own five cats, but their admission to the greenhouse is and has been strictly forbidden (which makes the cat all the more determined, as those who have cats know about them), so I cannot say. How about anyone else?

Speaking of animal depredation of CP in the field, it is now well known that except for trampling (which may actually help vegetative propagation by breaking up the rhizomes), domestic cattle do not seem to eat Sarracenias in the southeastern United States, and indeed a good, damp cow pasture often contains the best stands of *Sarracenia* since the cattle kindly consume the competition. Well, Joe Mazrimas one year noticed several bogs of Darlingtonia (CPN 1 :39) in which nearly every plant was decapitated—the hoods bitten off and gone. It turned out that this was done by deer who seem to have a taste for the hoods, possibly for their salt content, and the plants are often known locally as "deerlicks".

Until next time . . .

(Reprinted from Carolina Tips *with the permission of the Carolina Biological Supply Company.)*

NEMATODE-TRAPPING FUNGI

JULIANA T. HAUSER
From the Microbiology Department,
Carolina Biological Supply Company, Burlington, North Carolina 27215

Many species of flowering plants are known to be carnivorous, capturing and digesting small animal prey. These plants, including the Venus' flytrap, sundews, bladderworts, and pitcher plants, usually grow in soils that are deficient in useable nitrogen. The nitrogen-containing products of animal digestion are probably valuable nutritional supplements for these insectivorous plants.

Less well-known are the carnivorous fungi. Fungi that entrap (Fig. 1) and consume nematodes, or roundworms, are found in the soil and in fresh and salt waters. In fact, over 150 species of nematode-destroying fungi have been described.

Most of the nematode-destroying fungi belong to the Deuteromycetes or the Imperfect Fungi, those which have either a poorly understood or no known sexual stage. Nematode-destroyers are also found in the Oomycetes (water molds), the Chytrids, the Zygomycetes, and the Basidiomycetes. Recently, 10 species of mushrooms were found to be carnivorous on nematodes. These mushrooms commonly grow on decaying wood, an environment low in nitrogen. It is believed that nematode consumption supplements the low nitrogen level in their environment in a manner similar to the mode of nutrition of higher carnivorous plants.

NEMATODES

Nematodes are extremely abundant and occur in about every type of habitat (Fig. 2). Most of those living in the soil and in water are very small (0.1 to 1.0 mm). They are so abundant that a spadeful of soil or a bucketful of pond water may contain up to one million. Some nematodes cause serious animal diseases, such as trichinosis and roundworm and hookworm infections. Nematodes also cause millions of dollars in crop damage annually, but most nematodes are free-living and play a vital role in soil aeration and organic decomposition.

Nematodes are secretive animals with limited behavioral patterns. Just under their outer tough cuticle is a layer of longitudinal muscle. These muscles and the stiff cuticle limit their range of movement. The worms usually thrash about in a random, inefficient manner. However, for their size, they are powerful and enormously active. When you consider

FIGURE 1 *Arthrobotrys conoides*, the nematode-trapping fungus, showing the constricting rings that ensnare the nematodes.

FIGURE 2 *Rhabditis*, a common soil-inhabiting nematode.

the delicate nature of fungal hyphae, it is remarkable that the hyphae can trap and hold these worms until escape is impossible.

Predators and Parasites

The fungi that are predaceous on nematodes are, by and large, soil inhabitants. They grow and reproduce in a characteristic manner until exposed to nematodes or nematode extracts. Evidently, the change induced in fungal structure is stimulated by one or more substances collectively called nemin which are secreted by the nematodes. Nemin appears to contain several amino acids (valine, leucine, and isoleucine) and specific peptides of low molecular weights.

The carnivorous fungi are either endoparasites or predators, or both. The endoparasitic fungi do not form an extensive mycelium outside the host. They exist in the soil as conidia (asexual spores) which either become attached to the nematode's mouthparts or are ingested. The spores then germinate inside the gut wall, and mycelium develops throughout the host's body. Only the reproductive structures, the conidiophores and the conidia, penetrate the cuticle and develop outside the nematode's body.

Trapping Devices

The predatory forms produce extensive mycelium and, at intervals along their hyphae, various trapping devices such as adhesive knobs (*Dactylaria* sp.), lateral branches (*Monacrosporium* sp.), or nets that produce a sticky substance to which the nematode becomes attached. Once the nematode becomes trapped, these fungi then produce additional hyphae that penetrate the animal's body.

Still other predaceous fungi produce either constricting rings (*Arthrobotrys conoides*) or nonconstricting rings (*Dactylaria candida*). In the latter, the worm becomes wedged inside the ring and cannot disengage itself. These rings are easily detached from the fungus by the worm's thrashing about. However, these detached rings are still capable of penetrating and killing the worm.

Penetration of the host by the predatory fungus is by a haustorium, an absorbing organ produced on a hypha. Once inside the body of the nematode, the fungus swells up to produce a globe-shaped vesicle which has been given various baleful names (mortiferous excrescence, infection bulb, post-infection bulb). From this bulb, hyphae develop in both directions and consume the host's contents (Fig. 3).

FIGURE 3 *Rhabditis* with hyphae throughout its body.

The most dramatic trap is the constricting ring found in *Arthrobotrys*, *Dactylaria*, and *Monacrosporium*. This ring consists of three curved cells at the end of a short stalk extending from a hypha.

Ring Mechanism

The mechanism of ring closure is a fascinating one. The inner surface of the ring is sensitive to rubbing. A fine glass rod inserted through the ring and followed by gentle friction triggers closure. Other stimuli, such as a stream of dry air or heat, are also effective. The enlargement of the cells comprising the ring is accompanied by their vacuolation and by the stretching of the inside wall of the ring.

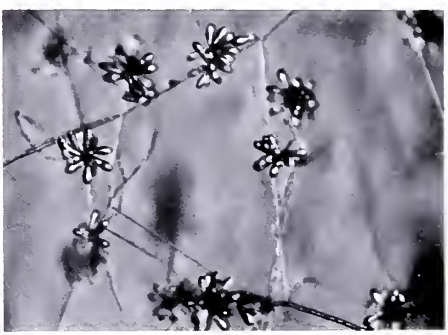

FIGURE 4 Conidia (asexual spores) of *Arthrobotrys conoides* form on unbranched, aerial conidiophores, while the hyphae penetrate the agar.

The stimulated cell constricts first, followed by constriction of the other two cells of the ring. Ring closure requires about 0.1 second. Volume changes within these cells are about

threefold. Several physiological changes probably occur during closure. These include:

1. Changes in membrane permeability allowing rapid water uptake.
2. Water uptake over the surface of the ring.
3. Changes in microfibrils making up the inner wall which allow this wall to become thinner. The inner wall of *Dactylaria brochophaga* has four layers, two of which rupture as the wall expands.
4. Changes in osmotic concentration allowing rapid uptake of water. Possibly the polymers within the cell are hydrolyzed, thus increasing osmotic concentration of cytoplasm and allowing water uptake until osmotic balance is restored.
5. Rearrangement of membranes. The rapid increase in cell volume and surface area necessitates a concomitant rearrangement of cell membrane materials within the cell. In fact, a network of cell-membrane-bound materials has been detected subjacent to the cell membrane in *Arthrobotrys dactyloides*. In expanded rings, a more usual type of plasma membrane has been found, suggesting that the cell-membrane-bound materials had contributed to formation of the enlarged cell membrane.

Contact with the rings is not entirely due to chance, but may be a result of chemotactic movement of nematodes toward the fungus. If nematodes are placed equidistant between two agar cubes of a predaceous fungus (one having been induced to form traps, and the other not), a significantly higher number of nematodes will move toward the cube with traps.

The capture of the nematode is quickly followed by its death, although it may struggle violently for a time. In the case of constricting rings, the constriction of the nematode's body may cause death. There is evidence that toxins may also be produced by predaceous fungi. *Arthrobotrys dactyloides* has been shown to produce a nematotoxin, the active ingredient being ammonia.

Nematotoxins are produced by conidia in some of the endoparasitic fungi as well. The conidia adhere to the cuticle of the animal and secretion of the toxin may immobilize the host animal until hyphae can penetrate its body.

FIGURE 5. *Rhabditis* caught by the constricting rings of *Arthrobotrys conoides*.

FIGURE 6. *Arthrobotrys conoides* exhibits increased sporulation at the site of nematode consumption.

Fungal Sporulation

Under natural conditions, fungal sporulation is often induced by a decrease in the level of available food supply. The reduction in food supply which leads to sporulation is preceded by a period of intensive feeding when the food supply is abundant.

For example, *Arthrobotrys conoides* in culture produces a moderate number of conidia around the periphery of the petri dish. This fungus is a rather innocuous looking one producing translucent, colorless hyphae and conidia (Fig. 4). In fact, you must observe the plate against a light source to see any growth at all. Conidia are two-celled and are produced on unbranched, erect conidiophores in a single whorl around the apex. Few to no constricting loops are formed in culture.

Within 24 hours after the culture is inoculated with the nematode *Rhabditis*, constricting rings or lassos are evident along the hyphae (Fig. 1). Within the next 24 hours, *Rhabditis* become entrapped in these lassos (Fig. 5). From 48 to 96 hours after inoculation, the entrapped roundworms cease movement and the animals' bodies show signs of deterioration. By the end of 96 hours, almost all traces of *Rhabditis* have disappeared. *Arthrobotrys conoides* then exhibits massive amounts of sporulation all over the culture, especially at the sites where the nematodes

were trapped and absorbed. Thus, the feeding period seems to trigger increased sporulation (Fig. 6).

Watching this fungus feeding on nematodes under a stereomicroscope is a fascinating laboratory demonstration guaranteed to engage students' attention.

Biological Control

Because some nematodes are serious plant and animal pathogens, some research has focused on controlling parasitic nematodes in the soil by the addition of the nematode-trapping fungi. Although results have been encouraging, no biological control methods have proven to be commercially practical at this time.

Further Reading

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PEST CONTROL

by Curtis Yax, 12 Division, Apt. 1, Oneanta, NY 13820

A while ago, I wrote to Mr. Joe Mazrimas concerning the elimination of small black flies and maggots which infested my new tropical sundew terrarium. The pests came from plants purchased from Australia. At first, I thought the flies would be a good food source for the plants. Within a month, the surface of the peat moss began to crawl repulsively with plump white maggots.

Joe suggested that I use a pest strip—his idea being that the gas vapor would kill the flies and eventually the maggot problem would be eradicated. At that time, I could not find any pest strips in the store because of the season. I bought a non-toxic product instead called Fly Ribbon (Terro), distributed by the Senoret Chemical Co., Kirkwood, MO 63122. The ribbon proved to be effective. It is very sticky, so if you have long hair like I do, care must be taken not to get it stuck to your locks or beard, and of course your plants. I taped it very securely to the back glass of the terrarium (when removed, the brownish glue stays on the glass and is very unattractive). This fly ribbon killed a multitude of flies while I killed the maggots with tweezers. Between the two methods, it took several months to get rid of them.

My wife, Michele, informed me that a store was selling an Insect Strip by Starbar for $3.99 (Starbar, Zoecon Corp., 12200 Denton Drive, Dallas, Texas 75234). This agricultural commodity is VERY TOXIC, so care must be taken when handling it.

I also had infestations of several chewing insects from the same plants purchased from Australia. Also, a small brown fly invaded the terrarium. When I used this pest strip, the infestations disappeared within 24 hours. Here are directions on working with the material. First, cut pieces of thick, sturdy plastic on which the smaller piece of strip will go. For a piece of pest strip 2" x 2", cut a piece of plastic about 5" x 5" for easy handling. This will also prevent poison from seeping and contaminating the soil. Next, put on some plastic gloves or thick plastic bags, lay out old newspapers and open the contents, being careful to unwrap only up to the desired amount. Avoid breathing in this vapor and try not to get too close to it. It smells somewhat like perfume. With a razor blade, cut a piece down the width of the bar for small pieces and use the length of the bar for bigger pieces. The strip is very hard and tough, so care must be taken to avoid

puncturing your gloves or cutting your fingers.

After you have the piece cut, use Elmer's glue (latex type) to secure the bar on the middle of the plastic piece. Wrap the unused bar and place it out of reach of children and pets. You will notice that it looks like cheese. Leave the area for a breath of fresh air and on your return, the bar should be securely fastened to the plastic. Now you can handle this without gloves and place it in your terrarium or by pots which have plants infested with ants, aphids, flies and many others. The insects will climb up the plants and die in a day or so. This strip also kills bugs which hide underneath leaves!

Remove the bars after checking the plants the next day or so, place in plastic bags separately, and then wrap them all in one bag. This is to prevent you from touching other bars when you stick your hand inside for just one bar. Repeat this treatment when pests reappear.

I have also found a product called "Algae Destroyer" suitable for tanks containing *Utricularia gibba* and *purpurea*. However, it will kill *Aldrovanda*. With only a few treatments, algae disappear forever. The directions for usage are adequate for 5 gallon aquariums and up. The chemical resembles chewable vitamin pills so these must be kept out of reach of children and pets. Smaller pieces can be used for small containers. The cost is $2.39 for 18 tablets and the address is: Aquarium Pharmaceuticals, P.O. Box 222, Perkasie, PA 18944.

PRELIMINARY REPORT ON MITE INHABITATION STUDIES IN SARRACENIAS

by Robert Naczi, 19 Boulder Brook Dr., Wilmington, DE 19803

For two weeks during mid-August, 1984 my ecology professor, Dr. Richard W. Fredrickson and I traveled through the southeastern United States studying the mites associated with *Sarracenia* species. Four species of mites have been described from the pitchers of *Sarracenia* species and are thought to live nowhere else. Little is known about these mites. In fact, they are reported from only three *Sarracenia* species. Hence our goal is to study their distribution, ecology and systematics.

Through the very helpful guidance of Drs. George W. Folkerts, Robert K. Godfrey and Donald E. Schnell, and supported by grants from Sigma Xi (the scientific research society), the Saint Joseph's University Sigma Xi Club, and the Claude E. Phillips Herbarium (Dover, Delaware), we collected pitcher contents from at least one population of each of the species of *Sarracenia*. We sampled all five subspecies of *S. rubra* and a few hybrids also.

As a result of processing the nearly forty samples we collected, I have found that mites occur in the pitchers of every species of *Sarracenia*. Each *S. rubra* subspecies has mites and so do the hybrids sampled. The mites appear to be most abundant in young pitchers which are in prime trapping condition and which contain abundant prey. Large pitchers in such condition may contain well over one hundred mites. The mites produce no obvious effects on the plants and may be commensals. I will now begin identifying these mites and plan to inform CPN readers of my findings.

Photo right:

N. albo-marginata scrambling through trees of Penang. Photo by Roger Shivas.

Variation in *Nepenthes albo-marginata*

by Roger G. Shivas, 27 Lobe Street, Bald Hills, 4036, Australia

Nepenthes albo-marginata is a widespread species that has been reported from peninsular Malaysia, northern Borneo and western Sumatra. Although widely distributed this species only occurs in a limited number of locations.

I have seen *N. albo-marginata* on Penang Island, atop Mt. Ophir and Kedah Peak in peninsular Malaysia, at Bako National Park in Sarawak and in the south of Sabah near the border with Brunei. This species has also been reported to occur on Nias Island off the west coast of Sumatra. *N. albo-marginata* appears to be restricted to coastal locations, expecially lowland hills and bluffs up to 1,000 metres in altitude.

There are at least two distinct forms of this species. In effect these two forms are separated by the South China Sea. The peninsular Malaysian form has large pitchers that measure up to 20 cm high and 3 cm wide. The form from Borneo has slender, pencil-like pitchers that measure up to 15 cm high an 1 cm wide.

Although the colour of the pitchers is not a reliable taxonomic characteristic the pitchers of the peninsular Malaysian form are crimson or heavily flecked with magenta. The form from Borneo is a lime green colour.

Further study and collections are necessary in order to determine whether these forms are sub-species or even species. However *N. albo-marginata* is easily identified by a white band adjacent to the peristome. The white band is formed by a dense layer of closely packed hairs. In older pitchers the band is less distinct. One plant observed on Mt. Ophir and thought to be a natural hybrid between *N. albo-marginata* and *N. sanguinea* still retained the white band.

At least four varieties of *N. albo-marginata* (var. *villosa, typica, tomentella* and *rubra*) have been described in the literature. It is not known whether any of these varieties correspond to the two forms mentioned in this article.

Although I have not seen *N. albo-marginata* on Sumatra the proximity of the island to the Malaysian peninsula indicates that it takes the form found there.

Nepenthes albo-marginata 'Penang form,' lower pitcher. Photo by Roger Shivas. See page 13.

Nepenthes albo-marginata 'Borneo form' upper pitchers. Photo by Roger Shivas. See page 13.

Drosera filiformis. Dry sandy spot in New Jersey Pine Barrens. Photo by David Butler. See page 16.

First leaves of *Drosera filiformis* in New Jersey Pine Barrens. Photo by David Lane. See page 16.

Drosera Hybrid Found In Pine Barrens

by David E. Butler (5114 Elm St., Bethesda, MD 20814)

During June, 1984, on a canoe trip to the Pine Barrens of New Jersey, rare hybrid specimens of *Drosera rotundifolia* × *intermedia* were located in a remote area. The hybrids were notable not only for their rarity, but also for their unusually large size. At least one specimen later produced some seed. It is not known whether seed from these hybrids will prove to be fertile.

The canoe trip was the highlight of a weekend camping trip attended by the writer and Phil Sheridan and Bill Scholl of Virginia. The Pine Barrens is well known as a habitat of the two parent *Drosera* and *D. filiformis* besides. We drove to New Jersey from the Washington, D.C. area on Friday night to camp and search for thses three species and other native CP and bog orchids.

Friday night, we camped at Chip's Folly campground in New Gretna. The campground has approximately 300 sites in a remote wooded location, on a brackish bay. *D. rotundifolia* and *intermedia* may easily be found at pond margins within the campground. Canoeing is possible at the campground, but the best CP stands are inland along fresh water lakes and rivers. One should always check whether a group will be camping at Chip's Folly. During our first stay at the campground, after an all-day canoe trip, we returned to find that the state motocross races were being held all around us. While the trail-bikers were congenial, the noise was of the all night variety. At six a.m., we were awakened by the roar of military jets on the way to a bombing run in the Pine Barrens target range. This is wilderness camping in New Jersey.

This time, however, the campground was notable for the massed chorus of thousands of frogs inhabiting the pond next to our campsite. Mating season was in full gear, and they were having an orgy! The noise was, however, not unpleasant and, after a four hour drive and several sixpacks shared between the campers, sleep came easily.

The next morning, we broke camp shortly before seven a.m. and headed for breakfast in nearby Tuckerton. We then proceeded by car into the Pine Barrens on Route 539. This road offers some excellent views of the dwarf pine forests that cover the area. At one point, the road crests a small hill. The pine forest is no more than four feet high. One can see for miles, towering above the forest like Paul Bunyan.

Near this area, where an abandoned road cuts through a sandy seep field, we found a large colony of *D. filiformis*. The colony extended over an area approximately one hundred yards long, ranging from a few feet to fifty feet wide, depending on the topography. Within the flat seepage area, in which the water table was at surface level with a pure sand strata, *D. filiformis* was the dominant species. The species could also be found in drier areas off to the side in great numbers. *D. rotundifolia* and *intermedia* were also present. *Rotundifolia* could be found only in shaded areas near the edge of the field, and *intermedia* only in the wettest portions of the seep area. I have seen other colonies of *D. filiformis* in the Pine Barrens, but none so numerous as this. I would estimate their numbers as in the tens of thousands. (See photos, p. 15.)

After a lengthy stop at the *D. filiformis* field, we proceeded to Oswego Lake, formed by a man-made dam on the Oswego River. The lake is perhaps a thirty minute drive from Route 539 over mostly washboard dirt roads. We put in the canoe at this lake, which is several miles long. The upper portion of the lake includes a ghost forest of drowned tree trunks that one may canoe through—carefully, so as to avoid being snagged on a submerged stump. Several large sphag-

num bogs line the shore of the lake, with extensive stands of *S. purpurea* and *D. rotundifolia*. *D. intermedia* commonly grows in shallow areas as an aquatic. In this environment, *D. intermedia* will develop an elongated stem and vigorous habit. With some overstatement, we labeled these the "tree form."

Continuing up the river, we found a pristine bog hidden by trees. The bog included the largest specimens of *D. filiformis* v. *filiformis* that any of us had ever seen, with leaves over twelve inches. *S. purpurea* was common throughout this area.

It was here that we located *D. intermedia* × *rotundifolia*. Several dozen mature plants were noted, many of which were outstanding specimens. In addition, many smaller plants were developing from old leaf tips. They were growing in a sopping sphagnum bog, almost in standing water, in a small clearing approximately 30 by 50 feet, surrounded by dense pine and cedar growth. Their growth habit, as may be expected, is intermediate between the parent species, with an upright rosette and nearly round leaves on long stems. The sheltered nature of the site, which nonetheless permits direct sun during most daylight hours, has undoubtedly contributed to the unusually robust nature of these specimens.

Most of these specimens remain in their home. A few, collected for further study, flowered during September. Flowers are white, like those of both parents. In culture, the plants have developed an attractive symmetry to the rosette habit that is not often present in either parent in the natural habitat. I have also observed that the dormant buds are much larger than with either parent. After flowering, a casual examination of the pods revealed a small number of seeds. Due to the surprising nature of the discovery, this amateur botanist collected only a few of the seeds. They are now being stratified and will be set out in the spring. It is unlikely that any will germinate, as sundew hybrids are generally thought to be sterile. However, as Red Sox fans are known to say, wait till next year! Next year will also provide an opportunity to search the Pine Barrens for the as yet un-

Large *Drosera rotundifolia*. Photo by David Butler.

CP Conservation (or lack of it) in the Gulf Coast Area

by Faith Campbell, Natural Resources Defense Council, Inc., 1725 I Street, N.W. Suite 200, Washington, D.C. 20006

As you may remember, in December, 1983, I wrote about the need for greater efforts to conserve carnivorous plant species. These plants continue to receive a low priority from both governmental and non-governmental conservation agencies. Nevertheless, some practical conservation programs are under way, including in the vital Gulf coast area. I thought I should report on these, as well as repeat my plea for CPN readers to join together to do more themselves.

The U.S. Air Force owns some of the best remaining pitcher plant bogs in Eglin Air Force Base in the Florida panhandle. The Florida Natural Areas Inventory estimates that there are hundreds of hillside seeps on the base, some of them a few acres in size. Species diversity and bog quality vary. Some have been damaged by visitors' construction of small dams on the creeks to create fish ponds; in others, shrub invasion is advanced. A good number, however, are in excellent condition. Pitcher plants may constitute 80% of the vegetation cover in some of these.

The Air Force apparently provides no special protection for the seeps. Military exercises generally avoid the wet areas, but hikers and hunters are not restricted.

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discovered hybrid of *D. filiformis* × *rotundifolia*.

The *rotundifolia* × *intermedia* hybrid has previously been reported in New Jersey (Sheridan, 1978; Schnell, 1976). *Intermedia* has also been reported to hybridize with *D. filiformis* (ibid) and *capillaris*. According to conversations with the author, Sheridan's observations were also made in the Oswego River basin, in a location several miles down river. The presence of the hybrid in disparate sites suggests that natural sundew hybrids may be more common than previously thought. This hypothesis suggests in turn that the likelihood of ultimately finding previously unreported hybrids such as *filiformis* × *rotundifolia* or *filiformis* × *capillaris*, is good.

There is an alternative hypothesis. Since hybrids with *D. intermedia* as a parent are found consistently, *D. intermedia* may be, for unknown reasons, an "easier" parent to work with when attempting artificial hybrids. Perhaps the pollen remains viable for a longer time, or the stigmas remain receptive longer during the time that the flower is open. The two hypotheses are not mutually exclusive. Both may be further explored during the 1985 season.

Authorities Cited

Sheridan, P. *New Jersey Pine Barrens*, 7 Carniv. Plant News. 107, 108 (1978)

Schnell, D. *Carnivorous Plants of the United States and Canada* 70 (1976)

CORRECTION

The ICPS Directory printed in CPN, December 1984, contains some errors in addresses. The correct listings should be

Lorne Dennison
780 E. 10th St.
N. Vancouver
CANADA V7L 2G1

Susan Sikes
180 N. Fourth St. #501
San Jose, CA 95112

REMINDER

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There is no intentional burning of the seeps. Those adjacent to long-leaf pine forests are burned regularly as a result of forestry management practices, but the sand pine forests are not burned so bogs there are more likely to suffer shrub invasion.

The Air Force apparently puts little importance on the pitcher plant ecosystem. Public pressure should be put on the service, especially officials at the base, to change this attitude. Minor changes—restrictions on dam building, burning of the bogs in the sand pine forest areas—could greatly enhance conservation of the ecosystem.

The U.S. Forest Service manages a few thousand acres of pitcher plant bogs in the national forests in Florida, Alabama, Mississippi, and Louisiana. The Forest Service attempts to locate the bogs as part of its general mapping of forest types. It then prevents building of roads, draining, skidding of logs, and, sometimes, grazing, in these areas. The Forest Service does carry out prescribed burns.

For example, Conecuh National Forest on the Alabama-Florida border has about 77 acres of bogs which have been identified over the years. Some locations were added by a survey for "sensitive" plants carried out in 1983. Grazing is allowed in the vicinity of the bogs, but its effect is monitored and the bogs will be fenced if damage is detected. The two largest bogs have been burned twice over the past 6-10 years. These bogs are relatively diverse, having 3 common *Sarracenia* species (*S. flava, S. leucophylla, S. psittacina*), other less common species, and a large variety of orchids.

Conecuh N.F. contains only 12 acres of the 50-acre Crawford bog; purchase of the remainder is a high priority if the owners become interested in selling.

The Forest Service requires a permit for commercial collecting of plants; issuance of such a permit for pitcher plants would not be likely.

The Forest Service could do more to protect the bogs. There is need for additional research; for example, Larry Hedrick at the Alabama office of the Forest Service would like advice on the timing and spacing of prescribed burns. At present, bogs are burned in late winter. The Forest Service could also desginate more of the bogs as special botanical areas or research natural areas. In the former, only activities that are compatible with protecting the target species are allowed. In the latter, only non-manipulative research is permitted. At least one Research Natural Area has been designated in Appalachicola N.F. in Florida; this 469 acre bog contains *S. psittacina* and *S. rubra*, which are considered endangered in Florida.

The Nation's primary wildlife conservation agency, the Fish and Wildlife Service, gives a high priority to protecting wetlands, but not those that are home to most carnivorous plants. The FWS has been mapping wetlands for 8 years; the focus is still on coastal wetlands and

Drosera intermedia × *D. rotundifolia?*
Photo by Joe Mazrimas

prairie potholes that support waterfowl.

More important to us, perhaps, are two studies of the causes of wetland destruction. The FWS is reviewing federal laws and regulations that provide tax or other incentives that in effect subsidize conversion of wetlands to other uses such as forestry or agriculture. The General Accounting Office, an investigatory arm of the Congress, is carrying out a similar study. These studies' recommendations should be sent to Congress later this year for consideration. Significant reduction of these subsidies would greatly benefit carnivorous plants on private lands.

Meanwhile, Congress is likely to try again to pass a wetlands bill that would give the FWS broader authority to purchase wetlands. (The bill was blocked last year by controversy over the House provision that would have resulted in dredging of a North Carolina coastal inlet.) Whatever the fate of the bill, purchase of pitcher plant bogs in the near future is unlikely due to the pressure to reduce the federal budget and the low priority given to wetlands of interest primarily for their flora.

Florida provides some protection to pitcher plant bogs through its Wetland Protection Act of 1984. A permit is required to modify "transitional" zones of this type. Florida also restricts collecting of endangered plants including *S. rubra* and *S. leucophylla*. The Florida Natural Area Inventory does not assign a high priority to this ecotype because the best examples are already in federal ownership.

The principal non-governmental conservation organization is the Nature Conservancy. While TNC has a nation-wide wetlands conservation program, carnivorous plant bogs in the Gulf coastal states have fallen through the cracks. One problem is the lack of state TNC programs in Alabama, Mississippi, and Georgia. The absence of personnel reduces the Conservancy's knowledge of opportunities to buy bogs; staff time to negotiate deals; and sources of local funding. (Land purchases are financed by a revolving fund which must be reimbursed.) In addition, land acquisition priorities are set by a ranking system based on the relative rarity of individual species. Therefore, the bogs, which generally contain species which have more than 20 sites throughout their ranges, rank low on the scale.

The Nature Conservancy has recently acquired a bog near Picayune, Mississippi; this purchase was made possible by a grant from a foundation and matching fundraising by a local arboretum. Interest in the bog stemmed from the presence of a plant species limited to only 14 occurrences.

Clearly, if the Nature Conservancy is to do more, it must receive support from carnivorous plant lovers, especially those who live in the Gulf states. TNC needs encouragement, information, and especially fund-raising help.

Outside the United States, bogs are beginning to receive a fair amount of attention. Conservation agencies and volunteer organizations in Ireland and Scandinavia are actively pursuing bog conservation in the face of threats by peat miners and foresters.

The International Union for Conservation of Nature and Natural Resources (IUCN) is the principal international conservation body; it works closely with World Wildlife Fund. IUCN has promoted wetland conservation since its funding in 1948, but has focussed on wetlands important to fauna. Since it is not satisfied with the results of its past efforts, IUCN is launching a 2-year wetland campaign this year. WWF will carry out a parallel one-year publicity and fundraising project. The goal of the joint campaign is to build a world-wide network of protected wetlands that includes all types of wetland ecosystems and protects all wetland species of conservation concern. Carnovorous plant bogs would be protected primarily by national efforts under the inspiration of the IUCN campaign. Among the priority areas for direct protective action are the Carrowbehy and Owenduff bogs in Ireland and Luiro Aapapeatland in Finland.

One of the tools for IUCN's reaching its goal is to develop a global network of

people and organizations that support wetland conservation.

IUCN is a membership organization; the carnivorous plant societies may wish to consider joining (although dues are substantial). In any case, the societies should make contact with the IUCN Wetlands Officer and become active participants in the network.

While it clearly would be inaccurate to say that nothing is being done to conserve America's carnivorous plant species, it remains true that the combined efforts are paltry compared to the need. Both government and non-government agencies need to hear from CP fanciers. You can provide evidence of public concern and support for whatever efforts they are making information and funds. This kind of project is best undertaken by an organized group, but individuals acting on their own can also be effective. I urge *CPN* readers to play a more active part in U.S. and global wetland conservation programs.

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□ = Books out-of-print

1. Carnivorous Plants, Gordon Cheers, Globe Press, Melbourne, $7.95.
2. Insectivorous Plants, Charles Darwin, AMS Press, 1893, 56 E. 13th St., N.Y., NY 1003, $27.50, 1893 ed.
3. * Plants that Eat Insects: A Look At Carnivorous Plants, Anabel Dean, Lerner Publications, 1977, 241 First Avenue, Minneapolis, MN 55401. $5.95.
4. Plants of Prey in Australia, Rica Erickson, Univ. of W.A. Press, 1968, World Insectivorous Plants, 2130 Meadowind Ln., Marietta, GA 30062, Cloth, $15.00.
5. □ * Animals & Plants That Trap, Phillip Goldstein, Holiday, 1974, Holiday House, Inc., 18 E. 53rd St., N.Y., NY 10022, $5.95.
6. Nepenthes of Mt. Kinabalu (in English), Kurata, S., Sabah National Park, World Insectivorous Plants, 2130 Meadowind Ln., Marietta, GA 30062, $7.00.
7. * Pitcher Plants, Carol Lerner, William Morrow & Co., N.Y. $11.00.
8. Carnivorous Plants, Francis E. Lloyd, Peter Smith, 6 Lexington Ave., Magnolia, MA 01930, $12.00, 1942 ed.
9. The World of Carnivorous Plants, J. and P. Pietropaolo, R.J. Stoneridge, Peter Paul Nurseries, 1974, $6.30.
10. □ * Insect-Eating Plants, L. and G. Poole, T.Y. Crowell, 1963, 666 Fifth Avenue, N.Y., NY 10003, $4.50.
11. □ * Plants That Eat Animals, J.H. Prince, Thomas Nelson, 1978, 407 Ave. S., Nashville, TN 37203, $8.95, 1979 ed.
12. CP of the U.S. and Canada, D.E. Schnell, John F. Blair, Publisher, 1976, 1406 Plaza Dr., SW, Winston-Salem, NC 27103, $19.95 plus shipping, 1976 ed.

☐ 13. Carnivorous Plants, Randall Schwartz, Avon Books, 1975, 959 Eighth Ave., N.Y., NY 10019, soft cover $1.25.

14. Pitcher Plants of Peninsular Malaysia & Singapore, Roger G. Shivas, Maruzen Asia Pte. Ltd., 51 Ayer Rajah Crescent #07-09, Singapore 0513. $9.80.

15. Carnivorous Plants, Adrian Slack, MIT Press, 1979, 28 Carleton St., Cambridge, MA 02142, $25.00, 1980 ed., 1984 paper $15.00.

☐ 16. Cultivating Carnivorous Plants, Allen Swenson, Doubleday & Co., 1977. Garden City, NY 11535, $7.95.

☐ 17. * Carnivorous Plants, John F. Waters, Franklin Watts, Inc., 1974, 845 Third Avenue, N.Y., NY 10022, $4.90.

18. * Carnivorous Plants, Cynthia Overbeck, Lerner Publications, 1981, 241 First Avenue, Minneapolis, MN 55401, $8.95.

19. * Secrets of the Venus's Fly Trap, Jerome Wexler, Dodd, Mead & Co., 1981, 79 Madison Ave., N.Y., NY 10016, $8.95.

1985 CP SOURCES

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Burleigh Park Orchid Nursery Ian & Pat Walters, 1419 Ross River Road, Kelso, TOWNSVILLE. QLD. 4815. Phone: 077 740008.		*Nepenthes*
Carnivorous Gardens P.O. Box 224 Stones Corner 4120 Brisbane, Queensland Australia	$.75	*Native seed*
Carnivorous Supplies P.O. Box 179 Albion Park N.S.W. 2527 Australia	2 international postal coupons or S.S.A.E. in Australia	*Drosera, Utricularia, Sarracenia*
Carolina Exotic Gardens P.O. Box 1492 Greenville, NC 27834	$1.00	*Dionaea, Drosera, Sarracenia, Darlingtonia, Pinguicula, Nepenthes & CP seeds, Sphagnum moss*
Country Hills Greenhouse Rt. 2 Corning, OH 43730	$2.50 refundable with order	*Nepenthes (20 varieties)*
Exoticana Seeds P.O. Box 184 Greytown 3500, South Africa		*Native CP seed*

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Lee's Botanical Garden P.O. Box 7026 Ocala, FL 32672	Free	*Sarracenia, Utricularia, Pinguicula, Nepenthes, Drosera, Dionaea, Heliamphoras, seed.*
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Milingimbi Nursery 69 Pringle Ave. Belrose, NSW 2085 Australia	Free	*Byblis, Cephalotus, Drosera, Dionaea, Nepenthes, Utricularia, Sarracenia, Pinguicula*
Orgel's Orchids Rt. 2, Box 90 Miami, FL 33187	Free	*Byblis, Dionaea, Drosera, Nepenthes, Pinguicula, Sarracenia, Utricularia*
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Robert Cantley P.O. Box 1200 B.S.B. Brunei, Borneo SE Asia	Free	*Nepenthes*
Renate Parsley 8 Langton Rd. Mowbray 7700 South Africa		*Native CP seed*
Sarracenia Nurseries Links Side Courtland Ave. Mill Hill, London NW7		
South West Seeds Doug & Vivi Rowland 200 Spring Rd. Kempston, Bedford MK428ND		
Thysanotus-Seed-Mailorder Postfach 44-8109 2800 Bremen 44 West Germany	Inquire	*Byblis, Darlingtonia, Dionaea, Drosera, Drosophyllum, Nepenthes, Pinguicula, Sarracenia, Utricularia*

W.T. Neale & Co., Ltd., B.M. & S. Lamb 16/18 Franklin Rd. Worthing, Sussex, BN132PQ England	Inquire	*Sarracenia, Dionaea, Darlingtonia seed*
Harold Weiner Kaiserstr. 74 3250 Hameln 1 West Germany	Inquire	*Aldrovanda, Byblis, Cephalotus, Dionaea, Drosophyllum, Drosera, Pinguicula, Sarracenia, Nepenthes*
World Insectivorous Plants 2130 Meadowind Ln. Marietta, GA 30062	$.50	*Dionaea, Drosera, Drosophyllum, Nepenthes, Sarracenia, Pinguicula, Byblis liniflora, Utricularia*
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Review of Recent Literature

A NEW FAMILY OF CARNIVOROUS PLANTS

by J.A. Mazrimas

Givnish, T.J., E.L. Burkhardt, R.E. Happel, and J.D. Weintraub.

Carnivory in the Bromeliad *Brocchinia reducta*, with a cost/benefit model for the general restriction of carnivorous plants to sunny, moist, nutrient-poor habitats.

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What really is a carnivorous plant? The authors of this paper propose a two part definition which is as follows:

The plant must be "able to absorb nutrients from dead animals juxtaposed to its surfaces, and thereby obtain some increment to fitness in terms of increased growth, chance of survival, pollen production, or seed set.

Second, the plant must have some unequivocal adaptation or resource allocation whose primary result is the active attraction, capture, and/or digestion of prey."

For some time, observers of the tropical forest canopy noticed the cup-like structure (called a tank) of epiphytic bromeliads which provide the opportunity to store not only water but many forms of animal life which accidentally fall in and drown and eventually decay into simple nutrients. The question is whether these plants are benefiting by this passive capture which is the subject of this paper.

In the definition above, the first portion divides the plant kingdom into those plants that kill or immobilize an insect just for defensive purposes such as *Roridula gorgonias*. Here, the sticky tentacles trap the insect as a defensive measure. Eventually, the leaf falls off the plant and the insect decomposes in the soil at the base of the plant. The second part of the definition restricts this type of activity being recognized as carnivory since nematodes and earthworms eventually die and decompose into simple nutrients that plants utilize.

There are 16 recognized genera of carnivorous plants either on logical or historical reasons. Not all of them fulfill the above definition. Some lack the attractants for trapping prey (*Lentibulariaceae*) and others lack digestive glands and rely on bacteria for digestion (*Heliamphora* and *Darlingtonia*). Most Bromeliads fall into the category of saprophytes because they lack the means to attract, digest prey and the means to prevent insect escape.

The *Brocchinia* bromeliad grows on a sterile sandstone surface in the Gran Sabana in southeastern Venezuela. It grows on the tepuis, flat-topped highly acidic sandy soil areas, about 3,600 feet (120 Ometers) and above the forest floor. Interestingly, it grows next to *Heliamphora*, *Drosera*, *Utricularia*, and *Genlisea* all of which are known carnivorous plants. It's a very common plant belonging to a genus with 18 known species and is found not only in Venezuela but also Guayana, but generally restricted to the Guyana Highlands.

What does the plant look like? The plant is about 12 inches (32 cm) in height and its yellowish-green leaves form a cylinder with the edges of the leaves overlapping tightly to retain water in the tank. The inside leaf surface is coated with a fine waxy powder which easily loosens when insects try to escape. The author demonstrates this with ants that failed to negotiate the vertical walls even though they could easily climb glass surfaces. The

Brocchinia reducta in habitat, Southeastern Venezuela.
Photos by T.J. Givnish, Harvard University.

fluid inside the tank is very acidic with a pH of 2.8-3.0. Microscopic examination of the plant showed no evidence for digestive glands.

The biomass within the tank was mostly ants (90%) and flies (5%) which is consistent with the fact that the tank fluid emits a sweet, nectarlike odor attractive to ants. This *Brocchinia* species is the only one of four others tested that had such a strong scent.

Trichomes, microscopic structures composed of specialized cells, are common in the Bromeliad family since they are capable of absorbing mineral nutrients essential to the well-being of epiphytic species. In *B. reducta,* these structures are very numerous at the inside base of the leaves and were shown to absorb amino acids in a radioactive form.

Protocarnivorous plants are those plants that have many of the preadaptations for attraction, capture, or digestion, but each of these traits may have other purposes with no clear allocation devoted solely to carnivory. Several species of Bromeliads fall into this category. The authors emphasize that the real crucial step for *B. reducta* is that it is capable of leaking a sweet smelling, volatile substance into its tank from glands in its leaf bases. They feel the key trait is attracting insects to the tank and this promoted the evolution of all the other functions that a true carnivorous plant must have.

This new representative of the carnivorous plant group is the least specialized of all the known carnivorous plants. It lacks digestive glands, specialized nectaries and has only a rudimentary waxy cuticle enclosing its water tank (lacks the bristles found in *Sarracenia*). Its traps are composed of single leaves formed into a rosette but retains the capacity to replace individual leaves as one dies which is not the case in *Heliamphora.*

This plant is an interesting case because it belongs to a genus in which not all the species are carnivorous and therefore affords a way of studying the various steps in evolution toward carnivory.

There are three factors, according to the authors, that all carnivorous plants must have in their environment to survive:

1) A nutrient-poor soil
2) A sunny location
3) Seasonally moist soil

It's a fact that there are 60% less carnivorous epiphytic angiosperms than terrestrial types. *Nepenthes* (6 of 71 species) and *Utricularia* (12 out of 280 species) are epiphytic. This brings up another question: why are carnivorous plants carnivorous? There are 3 possibilities: First, the nutrients that are absorbed can elevate the rate and seasonal duration of photosynthesis. There is some evidence for this from controlled feeding experiments and careful measurements of the leaf mass. Secondly, carnivory increases flower and seed production. Thirdly, that mineral nutrition is partly replaced by organic nutrition. On this latter point, all available evidence points to the fact that mineral nutrition is the chief means by which carnivorous plants achieve growth. Possibility No. 2 could easily be inversely related to No. 1. The energy and nutrients from a few less leaves could easily be directed to producing more flowers or seed.

It seems rather elementary that in nutrient poor soils, carnivorous plants will do better in a sunny, moist habitat than in a shady or dry one provided there is no limit on nutrient availability. Epiphytes must also have a good source of moisture as *Nepenthes* vines do by contacting the moisture in the soil via roots. Epiphytic *Utricularia* grow in wet cloud forests where water stress is rare. However, bromeliads are frequently found on shady perches or if in a sunny location are usually subject to dessication. This may account for the low numbers of epiphytic carnivorous plants.

Another factor why epiphytes are selected against may be because of the benefits that these plants get from certain species of ants that protect the plant. The plant provides shelter and nectar and the plant receives in a passive manner a supply of nutrients into the various plant

recesses in the form of food wastes, dead nestmates, food storage, etc. When it is all added up, the benefits may outweigh the plant's ability or need to become carnivorous.

I am looking forward to the next article on this new member of the carnivorous plant family when the authors will go into detail on various aspects not covered in this report.

Kondo, K. and P.S. Lavarack. 1984. A cytotaxonomic study of some Australian species of *Drosera* L. (Droseraceae). Bot. J. Linnean Soc. 88:317-333.

Fifteen species are presented along with eleven new chromosome counts. Droseras in Australian present a large aneuploid series. The lowest chromosome number is *D. paleacea* with 2n=10, giving a new basic number x=5 for the genus. Several rearrangements within subsections of the genus are proposed. DES

Taylor, Peter. 1984. Two new bladderworts from South India. Proc. Indian Acad. Sci. (Plant Sci.) 93:99-103.

Two small annual terrestrial Utricularias are herein described for the first time for South India: *U. ceceilii* and *U. lazulaina* with complete botanical descriptions and line drawings. DES

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Andreas Wistuba (Mudauer Ring 227, D-6800 Mannheim 52, West Germany) (TS) Many interesting CP including *Drosera arenicola, D. caledonica, D. hamiltonii, D. intermedia* 'Roraima', *D. prolifera, D. roraimae,* New South African *Drosera* species, *Pinguicula ehlersae, P. esseriana, Sarracenia* seedlings, *Utricularia livida,* (WTB) *Drosera acaulis, D. banksii, D. cyennensis, D. petiolaris* (different types), *D. ramentacea,* any other rare CP, South African, South American and Australian CP. (WTB) Seeds of rare *Sarracenia* forms and hybrids, *Biovularia, Genlisea, Heliamphora,* Mexican *Pinguicula* species, (W) Contacts to CP collectors all over the world.

Pinguicula primuliflora Wood & Godfrey grows along the Gulf coast of the United States between extreme eastern Louisiana and the central portion of the Florida Panhandle. It grows easily in cultivation and multiplies rapidly. Picture in habitat near DeSoto, Mississippi on 13 April 1983 by L. Mellichamp.